ERDC/CERL TR-01-27

US Army Corps
of Engineers®
Engineer Research and
Development Center

Management System for Fluid Storage Tanks at Fort Lewis, WA

Jearldine I. Northrup, Joyce C. Baird, Donald J. Schiller,
and James F. Lee

March 2001

Construction Engineering
Research Laboratory

**Fort Lewis
Army Installation
Fort Lewis, Washington**

ERDC/CERL TR-01-27

US Army Corps
of Engineers®
Engineer Research and
Development Center

Management System for Fluid Storage Tanks at Fort Lewis, WA

Jearldine I. Northrup, Joyce C. Baird, Donald J. Schiller,
and James F. Lee

March 2001

Construction Engineering
Research Laboratory

**Fort Lewis
Army Installation
Fort Lewis, Washington**

Foreword

This study was conducted for Fort Lewis located in Washington, under Military Interdepartmental Purchase Request (MIPR) 0CCERL3012, "Remote UST Telemetry Project." The technical monitor was James Lee, AFZH-DWS-RNB.

This work was performed by the Environmental Processes (CN-E) Branch, Construction Engineering Research Laboratory (CERL), the U.S. Army Engineer Research and Development Center (ERDC). Donald J. Schiller was project manager for MSE Technology Applications (MSE-TA), Butte, MT, which provided engineering design services and construction and installation of equipment. The CERL principal investigator was Jearldine I. Northrup. Dr. Ilker R. Adiguzel is Branch Chief, CN-E, and Dr. John Bandy is Chief, Installations Division, CN. The associated Technical Director was L. Michael Golish, CEERD-CVT. The ERDC technical editor was William J. Wolfe, Information Technology Laboratory. The Acting Director of CERL is William D. Goran.

CERL is an element of the U.S. Army Engineer Research and Development Center (ERDC), U.S. Army Corps of Engineers. The Director of ERDC is Dr. James R. Houston and the Commander is COL James S. Weller.

Contents

1 Introduction

Background

Fort Lewis Military Reservation is an 86,176 acre Army installation located in western Washington State. Fort Lewis' force structure includes I Corps Headquarters, which commands all Forces Command units at Fort Lewis. I Corps Headquarters conducts planning and also acts as a liaison with other active and reserve component units in the continental United States and active duty units located around the Pacific Rim and in Hawaii. Fort Lewis directly supports the Yakima Training Center, located in eastern Washington, and six Base Realignment and Closure (BRAC) installations in Washington and California.

Some of the military and nonmilitary organizations at Fort Lewis perform services and functions that require the use of hazardous substances and that generate hazardous waste. These services include the maintenance of over 4500 installation elements, including Fort Lewis' buildings and infrastructure (roads and utilities), and operation and maintenance (O&M) of over 3000 vehicles and nearly 1500 pieces of equipment including aircraft, weapons systems, power generators, and communications equipment. Fort Lewis also houses a major hospital, several medical and dental clinics, printing and graphics facilities, materials storage warehouses, and crafts shops.

Fort Lewis Pollution Prevention Plan

The Fort Lewis Pollution Prevention Plan provides a specific plan and implementation schedule for the reduction of hazardous substance use and hazardous waste generation through selected pollution prevention opportunities. A formalized 5-year pollution prevention plan was completed in September 1992, with 1991 as the baseline year.

Fort Lewis planners have worked with regulators to ensure that the new plan meets State requirements, and also with the requirements of the Department of Defense and Executive Order 12856. The pollution prevention plan had baseline years of 1992, 1994, and 1996 and was submitted to Washington State Department of Ecology in September 1997. In September 1997, Fort Lewis received a Governor's Award for Outstanding Achievement in Pollution Prevention at the

Washington State capitol. In recognition of the installation's steady improvements in implementing pollution prevention measures, Governor Gary Locke presented Lt. Gen. George A. Crocker with the *Consistent Excellence in Pollution Prevention* Award. A summary of Fort Lewis' Pollution Prevention Plan has been published to the World Wide Web (WWW) at URL:

http://128.174.5.51/denix/Public/News/Earthday97/Awards/lewis/fortlew.html#Pollu

Overview of the Current Project

The U.S. Army Engineer Research and Development Center (ERDC), Construction Engineering Research Laboratory (CERL) and contractor MSE Technology Applications (MSE-TA) were tasked with electronically consolidating fluid storage tank information for underground storage tanks (USTs) and aboveground storage tanks (ASTs) at Fort Lewis. Fort Lewis has approximately 62 regulated and over 2000 unregulated tanks in service. A recent inspection of the regulated tanks resulted in the issuance of several notices of violation (NOVs). The Fort Lewis environmental office and public works has expressed a commitment to expediting the task of bringing all tanks within compliance. The installation of a centralized monitoring and alarming system for the fluid levels and leak detectors is part of the three-part program for bringing the tanks into both regulatory and legal compliance:

1. *Proof of Concept Demonstration (POCD).* This first task is to demonstrate an integrated system of limited scope. The demonstration included the functions of data communications, storage, alarming, and display. One regulated tank was connected by telephone line to a dedicated computer. This monitoring computer included installed monitoring software, which initiates a call several times a day to download and display the tank information. The system was also set up to allow the compliance officer to initiate the call manually at any time.
2. *Connection of Regulated Tanks.* This task will assess methods of connecting the regulated tanks to the monitoring system computer, and will provide data connection, storage, and display for as many of the remainder of the regulated tanks as funding allows.
3. *Connection of the Unregulated Tanks.* This task will demonstrate the existing system and solicit funding for connection of as many of the remaining unregulated tanks to the monitoring system as possible.

Objectives

The overall objective of this work was to test and demonstrate the feasibility of an integrated monitoring and alarm system for USTs and ASTs at Fort Lewis, WA, and to install the system on all regulated tanks and as many unregulated tanks as possible.

The specific objective of this first part of the project was to conduct a proof-of-concept demonstration designed to quickly provide a working "core" system on a limited number of tanks, which may be easily expanded to include more tanks.

This small system was also intended to be used as a demonstration platform to obtain support for future expansion, as well as to provide an opportunity to work out problems early before expansion begins.

Approach

This first stage of the project involved the following steps:

1. Regulated tanks that were not slated for decommissioning were connected to the monitoring system, as funding allowed.
2. Unregulated tanks were considered a second priority. (A common problem with the unregulated tanks is that they usually lacked functional tank gauges.)
3. Several methods were studied for communicating the tank data to the central monitoring computer, based on the requirements for connection. The most appropriate method to connect each tank was chosen from this "shopping list" of methods.
4. Each tank was assessed to determine the most practical method to connect it to the monitoring system computer. Many tanks were unique in their type of gauge interface and the availability of a network connection near the tank; appropriate interfaces were designed to match individual tanks.
5. Once a tank was connected to the monitoring computer, the addition of another tank to the system was simply a matter of copying a software module and completing another tank configuration.
6. The monitoring system was installed to easily support expansion to include any or all of the approximately 2000 or so remaining tanks at Fort Lewis.

Mode of Technology Transfer

This work extends existing programs at Watervliet Arsenal and Corpus Christi Army Depot. Several concepts used here were proven in operation at those locations, and were refined for application at Fort Lewis. This report will be made available on the CERL and the Fort Lewis web sites.

The CERL web site address is: http://www.cecer.army.mil/

The Fort Lewis web site address is: http://www.lewis.army.mil/publicworks/Fuel.htm

Units of Weight and Measure

U.S. standard units of measure are used throughout this report. A table of conversion factors for Standard International (SI) units is provided below.

SI conversion factors		
1 in.	=	2.54 cm
1 ft	=	0.305 m
1 yd	=	0.9144 m
1 sq in.	=	6.452 cm^2
1 sq ft	=	0.093 m^2
1 sq yd	=	0.836 m^2
1 cu in.	=	16.39 cm^3
1 cu ft	=	0.028 m^3
1 cu yd	=	0.764 m^3
1 gal	=	3.78 L
1 lb	=	0.453 kg
1 kip	=	453 kg
1 psi	=	6.89 kPa
°F	=	(°C x 1.8) + 32

2 Tank Monitoring System Description

The Fort Lewis tank monitoring system has three subsystems: (1) Tanks and Tank Gauges, (2) Communications, and (3) Monitoring and Reporting Station. The following sections describe the three subsystems.

Tanks and Tank Gauges

The tank gauges on regulated tanks have strict regulatory requirements for installation and maintenance, and were determined to be outside the scope of this project. It was assumed that the gauges were, or soon would be, brought up to code to support effective monitoring and alarming.

The gauges for most of the regulated tanks were quite sophisticated systems that were able to monitor many tank parameters important to regulators. The vendors for the tank gauges to be installed are Veeder Root TLS-350, Ronan X76LVCS, and Petrosonic III. Appendix A gives vendor contact information and lists the available parameters for the Veeder Root TLS-350 gauge system.

The three gauge vendors above supply communications options that can be delivered with the unit, or installed later. These options are Standard RS-232 port, or telephone modem.

Communications

The communications link between tanks and the monitoring computer was designed based on the type of tank gauge, and proximity of the tank gauge to normal communications channels. A communications survey was conducted for each regulated tank to produce a working table (Figure 1 shows an example), to be used as the basis for the design.

Facility Owner (user level)	Automatic Tank Guage Monitoring System	Building Number	Additional location information	Tanks at site	Facility Type	Proposed Status	Tank ID. Numbers/ Tank Capacity (in gallons)	Has ATG and has Commo	Needs ATG and Commo	Needs Commo only	Needs ATG only
528th Quartermaster Bulk Site	ENCOMPASS/ Arizona Equipment	3477	Gray Army Airfield	2	aviation	active	3477-1(20,000) 3477-2(20,000)	2			
528th Quartermaster Bulk Site	VeederRoot TLS-350	3138	Main Post	4	bulk	active	3138-5(25,000) 3138-6(25,000) 3138-7(10,000) 3138-8(5,000)	4			
528th Quartermaster Bulk Site	VeederRoot TLS-350	9635	Logistics Center	5	bulk	active	9635-3(20,298) 9635-4(20,298) 9635-5(12,217) 9635-6(6,099) 9635-7(6,099)	5			
24th Quartermaster Bulk Site	VeederRoot TLS-350	11 B 50	North Fort	3	bulk	active	11B50-3(20,000) 11B50-4(20,000) 11B50-5(20,000)	3			
AAFES Retail	VeederRoot TLS-350	2407	Stryker Shoppette	3	commercial	active	2407-5(12,000) 2407-6(12,000) 2407-7(12,000)	3			
AAFES Retail	PETROSONIC III/ Red Jacket	6038	Gateway Shoppette	4	commercial	active	6038-1(10,000) 6038-2(10,000) 6038-3(10,000) 6038-4(10,000)	4			
AAFES Retail	VeederRoot TLS-350R	9052	Madigan Shoppette	3	commercial	active	9052-1(12,000) 9052-2(12,000) 9052-3(12,000)	3			
PW	VeederRoot TLS-350R	2051	Main Post	2	fuel point	active	2051-4(15,000) 2051-5(15,000)	2			
DPCA	Ronan X76LVCS	8981	American Lake/ North Fort	2	marina	active	8981-1(1,000) 8981-2(1,000)	2			
DPCA	None	3205	Gray Army Airfield	1	aviation	active	3205-4 (12,000)		1		
1st SFG	None	9145	Main Post	2	fuel point	active	9145-1(6,000) 9145-2(10,000)		2		
29th SIG	None	3381	Main Post	1	fuel point	active	3381-1(20,000)				1
864th ENG	None	3392	Main Post	3	fuel point	active	3392-1(20,000) 3392-2(20,000) 3392-3(500)				3
Directorate of Logistics	None	9580 (9595)	Logistics Center	3	fuel point	active	9580-8(1,000) 9580-9(4,000) 9580-10(10,000)		3		
1115th SIG/PW	None	2003	Main Post	1	generator	active	2003-3(300)				1
Corps HQ	None	2025	Main Post	2	generator	active	2025-(1,000) 2025-(2,500)				2
MAMC	None	9040	Madigan Army Medical Center	2	generator	active	9040-1(40,000) 9040-2(40,000)				2
DOL/PW	None	9500	Cannibalization point	1	generator	active	9500-2(300)				1
Waste Water Treatment Plant/ PW	None	7500 (7509)	Solo Point	1	generator	active	7500-1(1,000)				1
MAMC/PW	None	9580 (9576)	Logistics Center	1	generator	active	9580-7(1,000)				1
1st SFG/PW	None	9190	Main Post	1	generator (Non-Regulated)	active	9190(1,000)				
PW	None	3850	Boiler Plant	1	generator	close (demo)	3850-2(1,000)				
PW	None	4535	North Fort/ Outfall vic. Paint Ball Area	2	skimmer (Non-Regulated)	active					
PW	None	PO 1407	Main Post/ Outfall vic. Post Laundry	1	skimmer (Non-Regulated)	active					
PW	None	vic. 3916	Main Post vic. 168th EN	1	skimmer (Non-Regulated)	active					
PW	None	vic. 3392	Main Post vic. 864th EN	2	skimmer (Non-Regulated)	active					

Figure 1. Regulated tank inventory.

Three communications methods were evaluated for each tank:

1. *Telephone Line Connection.* The telephone connection is made through a nearby phone line. This method was selected for tanks with installed Veeder-Root and Ronan tank gauging systems that had modem options available.
2. *Network Connection.* The network connection is made through a nearby Ethernet local area network (LAN) fiber optic cable. Interface electronics would be installed to connect the tank gauge to an addressable node on the fiber-optic LAN.
3. *Radio Connection.* The radio connection is made through a radio communications hub located near the monitoring computer, or at a central location within the facility to minimize transmission distances.

Monitoring and Reporting Station

The monitoring and reporting station is the "heart" of the system. It consists of a personal computer with a tank status and alarming display. This computer resides on the desk of the compliance officer in Public Works directorate.

Tank levels and alarm status are displayed on several monitoring screens developed and installed on commercial off-the-shelf software (COTS).

3 Technical Implementation

Several methods can be used to bring USTs or ASTs under compliance:

- decommissioning the tank by removal or inerting in place
- replacing or upgrading the tank and/or gauging system to allow support of current regulations
- installing remote instrumentation to provide close monitoring of leaks, spills, overfills, or unauthorized dumping into a tank.

ASTs were included in this project because of a number of ASTs on site that pose an environmental risk.

The compliance method used at Fort Lewis for each tank was based on the evaluation of many factors, and was subject to Washington State Underground Storage Tank Regulations (Chapter 173-360 WAC). A summary of relevant portions of this regulation, taken from Washington State Publication # 94-32, *Summary of Requirements for Underground Storage Tanks*, is included as Appendix B to this report. Many underground storage tanks were decommissioned, and this released some funding for a smaller number tanks that were more vital to the mission.

Tanks used to store heating oil on the premises for consumptive use are excluded from Federal UST regulations. However, State or Territorial regulatory agencies may regulate these tanks. The State of Washington does not regulate these tanks according to the information from this U.S. Environmental Protection Agency (USEPA) website:

http://www.epa.gov/swerust1/heatoil.htm

"Heating oil" includes several grades of petroleum fuel oils: No. 1, No. 2, No. 4-light, No. 4-heavy, No. 5-light, No.5-heavy, No.6, Navy Special Fuel Oil, and Bunker C, and No.2 diesel fuel and kerosene (when used for heating purposes only).

The term "consumptive use" is not intended to apply to heating purposes only. The definition of consumptive use extends to any on-site use that may include

heating, or generation of emergency power, steam, process heat, or electricity. The exclusion does not apply to tanks storing heating oil for resale.

The term "premises" is not limited to the building where the heating oil is stored; it includes any location on the property on which the building resides. Thus, centralized heating units using heating oil that serve more than one building on the same property would qualify for exclusion.

The urgency of the situation at Fort Lewis required that the evaluation and selection of the compliance method to be used for each tank was to parallel the design of the remote monitoring system. In this project, the more important tanks were considered in the first phase of the project, where "importance" was determined by size of the tank, risk of exposure, and importance to the mission. A prioritized list helped schedule the design effort. A number of tanks were removed before effort was wasted on communications scoping or other design tasks.

The following sections outline the technical implementation of the three subsystems of the Fort Lewis tank monitoring system.

Tank Gauges

A good tank gauging system on a regulated tank can satisfy the release protection requirement of the regulations. Gauges can monitor for leaks by using approved methods such as groundwater contamination monitoring (using vapor or water analysis), interstitial monitoring (double-wall tank integrity monitoring), or inventory control using precision level monitoring.

Most approved tank gauging systems on the market today are supplied with connections to allow remote monitoring. The connections are usually two classes: analog/discrete, or serial/digital.

Analog/Discrete

An analog/discrete connection will provide a signal that can connect to interface "black boxes" that can in turn connect to Ethernet networks, modems, or radios. The analog is usually what is called 4-20 mA, or current between 4 and 20 milliamps to represent the tank level from zero to 100 percent full. The "discrete" connection is an available relay contact that will close or open following an important tank alarm, indicating an event such as leak or overfill alarm.

Serial / Digital

Serial/digital connections will provide an encoded stream of data over a pair of wires that can connect directly to modems or radios, or interface with Ethernet networks. The data communicate encoded tank status such as tank level in inches, or whether a leak alarm has occurred. Usually a remote system accesses a serial/digital gauge through an industry standard RS-232 port on the gauge, sends a request for the data, then waits for the response as a stream of data.

Tank gauges vary in sophistication from simple tank level monitors to full featured systems designed for use in gas stations, which also include water level gauging and automatic leak testing sequencing. For this project, the sophisticated Veeder Root TLS-350 systems were the first tank gauges connected. (These were the systems already in use on large fuel oil USTs.)

Communications

The data communication link connects to either the serial/digital or analog/discrete port on the tank gauge and electronically transmits the required tank status to the central monitoring and reporting station. Three possible methods for obtaining data from the tank are:

1. *Scheduled Automatic Update.* In this case, a call is initiated from the monitoring and reporting station. (For example, a daily report may be programmed to call-up at 4:00 a.m.)
2. *Update on Demand.* An update command may originate from the monitoring and reporting station. (For example, if a compliance officer requires an immediate report update, the system can generate current information on demand.)
3. *Update Initiated from the Tank Gauge.* (For example, an immediate data transmission would occur when the tank overfill alarm is activated.)

The following sections describe several data communications methods that were investigated for each tank installations.

Telephone Line with Dial-Up Modem

This method uses existing Fort Lewis dial-up telephone system lines and a modem at both the tank gauge and the monitoring and reporting stations to communicate tank data. The monitoring computer periodically dials each tank in rotation and downloads the current data. If the tank goes into alarm, a feature allows the tank gauge to automatically initiate an immediate call. At Fort

Lewis, telephone line connections are less costly for many tank connections. Most tanks have a phone line nearby, and modem costs are minimal.

Network Connection

This method uses the existing Fort Lewis Ethernet network to connect the tank to the monitoring and reporting station. For this link, an interface device is connected between an Ethernet Hub port located near the tank and the tank gauge connection. This will allow direct electronic access to the tank data from any other port on the network, as long as the correct communications protocol is observed.

Radio Modem

This approach uses techniques similar to the telephone dial-up modem described above. The radio modem was considered primarily for the remote tank locations without phone line or network connections within practical wiring distance. For example, this method was practical for use with tank 3205, which is an underground aviation fuel tank located on an airfield quite removed from network or phone lines.

For radio modem communication the tank-monitoring computer is connected by a serial connection to a nearby radio master base station. Through this base station, the computer broadcasts a "request for data" signal that includes a unique tank address. All tanks with a remote terminal unit (RTU) radio receive the request simultaneously, but only the RTU with the matching address will answer with the tank data stream. All tanks are "polled" sequentially in this manner every minute, hour, or day as required. A master base station can serve from 20 to 50 RTUs, depending on polling speed and message size. The transmission rate selected for Fort Lewis is 1200 bits per second (bps), which is considered relatively slow in the modern computer communications world. However, the speed requirements for this project were low; 1200 bps radio modems are adequate and significantly less expensive than faster communication devices.

The base station would use an omni-directional antenna to transmit and receive in all directions. The RTUs would use a yagi style antenna, which provides best communications signal strength when the yagi is pointing at the base station.

Two basic methods of radio communications were evaluated for Fort Lewis:

1. *Frequency Modulated (FM).* In this application, FM radio communication operates in the nominal 150 Megahertz fixed frequency range. FM power levels

would be 5 W for the RTUs and 25 W for the base station. The required FCC license can be obtained with the support of the radio vendor. The Directorate of Information Management (DOIM) is responsible for the coordination of radio frequency assignments, and would approve the request for frequency assignment.

2. *Spread-Spectrum (SS)* – SS radio communication rapidly changes frequencies in a preprogrammed sequence. Spread-spectrum requires no FCC licensing at low power levels, and is ideal for distances of less than approximately 2000 ft. This application was not well suited for use at a large installation such as Fort Lewis, where costly repeaters would likely be required to boost the effective distance of SS radio transmitters.

Monitoring and Reporting Station

The monitoring station consists of a personal computer and Microsoft™ Windows NT 4.0 operating system. CiTect™ brand Human Machine Interface (HMI) commercial off-the-shelf (COTS) software was installed to support graphical-based monitoring, alarming, trending, communications, and alarming/trending database. The monitoring station computer is located in offices of the public works directorate.

A tank monitoring software application was developed for the monitoring computer on the CiTect development platform. HMI software systems are typically very powerful tools for displaying information, or controlling a process. Numerous "screens" can be called up for viewing. Each screen can provide graphical display of various processes, functions, or areas of a facility.

The tank monitoring application has a "main" screen, which automatically loads and displays when the computer is turned on. This screen is a top-view bitmapped graphical map of the Fort Lewis site with all tanks represented at the respective locations on the map showing the tank level, and any alarms. Any individual tank icon can be "double-clicked" to invoke a more detailed display screen of the tank, which shows the vessel and status, various details of the tank, and the tank location. Also, alarm and level histories are stored and available for display and printing. This allows more careful diagnostics to determine if the tank has, or is developing a serious problem.

4 Summary

This work has tested and successfully demonstrated the feasibility of an integrated monitoring and alarm system for USTs and ASTs at Fort Lewis, WA. One regulated tank was connected through a telephone connection to a dedicated computer. This monitoring computer included installed monitoring software, which initiates a call several times a day to download and display the tank information. The system was also set up to allow the compliance officer to initiate the call manually at any time.

This working "core" system, installed on a limited number of tanks, may be easily expanded to include more tanks. Once the needed support for future expansion is gained, both regulated and unregulated tanks may be linked to the monitoring system computer, to provide continuous data connection, storage, display, and alarms.

Appendix A: Available Tank Parameters

Information about the Veeder Root TLS-350 is available through URL:

http://www.veeder-root.com/products/tls-350r_tech.shtml

Information about the Ronan X76LVCS is available through URL:

http://www.ronan.com/x76lvcs.htm

Information about the Petrosonic III is available (by clicking "ATG & Leak Protection") through URL:

http://www.epa.gov/region07/programs/artd/ustbx/index2.htm

This appendix includes excerpts from Veeder Root TLS350 Gauge Operating Manual. Note that the TLS350 is an example of typical high-end tank gauging system – all parameters are accessible from dial-up modem and special access software.

Table 5: In-Tank Leak Detection Displayed Messages

ANNUAL TEST ALARM	Alarm	An annual in-tank leak test has not been successfully completed within the preset time period.	Rerun in-tank leak test. If second test fails, call for service.
ANNUAL TEST FAIL	Alarm	In-tank leak (0.10 gph) test failed.	Rerun in-tank leak test. If second test fails, call for service.
ANNUAL TEST WARNING	Alarm	An annual in-tank leak test has not been successfully completed within the preset time period.	Rerun in-tank leak test. If second test fails, call for service.
CSLD INCR RATE WARN	Warning	An excessive amount of fluid leaked into the tank during a test period.	Call for service following the procedures established for your site.
DELIVERY NEEDED	Warning	Product level dropped below preset limit.	Call for delivery.
GROSS TEST FAIL*	Alarm	In-tank leak (3.0 gph) test failed.	Rerun in-tank leak test. If second test fails, call for service.
HIGH PRODUCT ALARM	Alarm	Product level in tank rose above preset limit.	Do not allow additional delivery until product is dispensed below preset limit.
HIGH WATER WARNING	Warning	Water detected in tank exceeds preset limit.	Remove water from the tank.
INVALID FUEL LEVEL (Mag probes only)	Alarm	Fuel level dropped to a point below the minimum detectable level or only one float is present.	Call for delivery.
LEAK ALARM	Alarm	A static in-tank leak test failed.	Rerun in-tank leak test.
LOW PRODUCT ALARM	Alarm	Tank level dropped below preset limit.	Call for delivery.
LOW TEMP WARNING	Warning	Probe temperature drops below -4°F.	Probe returns to normal operation after probe temperature rises above 0°F.
MAX PRODUCT ALARM*	Alarm	Product level rose above preset limit.	Stop delivery. Do not allow additional delivery until product drops below preset limit.
NO CSLD IDLE TIME	Warning	System has not had enough idle time over previous 24 hours to run a statistical leak detection test.	Stop dispensing fuel from this tank until CSLD test is complete.
OVERFILL ALARM	Alarm	Potential overflow of tank may occur.	Stop delivery. Check for spillage.
PERIODIC TEST ALARM	Alarm	A periodic in-tank leak (0.20 gph) test has not been successfully completed within the preset time period.	Rerun in-tank leak test. If second test fails, call for service.

Table 5: In-Tank Leak Detection Displayed Messages (Continued)

PERIODIC TEST FAIL*	Alarm	In-tank leak (0.20 gph) test failed.	Rerun in-tank leak test. If second test fails, call for service.
PERIODIC TEST WARN	Warning	A periodic in-tank leak test has not been successfully completed within the preset time period.	Rerun in-tank leak test. If second test fails, call for service.
PROBE OUT	Alarm	Hardware failure - probe or interconnecting wiring to console.	Call for service.
SETUP DATA WARNING	Warning	System setup problem or probe out on startup.	Reenter tank setup for problem tank or test probe on another channel.
SUDDEN LOSS ALARM	Alarm	System detects loss of fuel during an idle period.	Check for gross leak.
TANK TEST ACTIVE	Warning	In-tank leak test underway.	Do not dispense fuel from this tank until message disappears.
TANK SIPHON BREAK	Warning	Siphon break valve has shut down manifold for tank test.	Clears when tank test completes.

Table 6: In-Tank Leak Detection Invalidation Criteria

Printout Message (Not displayed)	Probable Cause	Action
RECENT DELIVERY ERROR	A delivery occurred during the leak detect test or less than 8 hours before beginning the leak detect test.	Retest, waiting longer than 8 hours after last delivery
LOW LEVEL TEST ERROR	Fuel level is too low during a tank test.	Need fuel delivery to raise fuel level.
FIRST LEAK PERIOD ERROR	System was unable to obtain enough valid samples to start a leak test during the first leak period (first half hour).	Call for service following the procedures established for your site.
LAST LEAK PERIOD ERROR	System was unable to obtain enough valid samples to start a leak test during the last leak period (last half hour).	Call for service following the procedures established for your site.
TEMPERATURE OUT OF RANGE	Temperature reading is below 0° F or above 100° F.	Wait for temperature to reenter the probe's operating range.
TEMPERATURE CHANGE TOO LARGE	Fuel temperature changed by more than 0.1 degree per hour since the reference period (the first hour of the test).	Retest.
CHANGE IN TANK TEMPERATURE ZONE (Magnetostrictive Probes only)	Fuel temperature changed by more than 0.4 degree per hour or the temperature thermistor is covered.	Retest. If the problem continues, call for service following the procedures established for your site.

Table 6: In-Tank Leak Detection Invalidation Criteria (Continued)

Printout Message (Not displayed)	Probable Cause	Action
CHANGE IN HEAD TEMPERATURE (Magnetostrictive Probes only)	Temperature of probe electronics changed too drastically.	Retest.
LEAK TEST TOO SHORT	Longer test time needed.	Retest. For manual test runs, allow longer test time. For programmed test runs, program a longer test time.
PERCENT VOLUME TOO LOW (Mag1 Probes only)	Fuel level is below "LEAK MINIMUM ANNUAL" percentage or LEAK MINIMUM PERIODIC.	Call for delivery.
INVALID FUEL LEVEL (Magnetostrictive Probes only)	Fuel level is too low, causing the fuel and water floats to be too close together.	Call for delivery.
PRODUCT LEVEL INCREASE	Fuel volume increased significantly during the test. Tank is not thermally stable or fuel is draining from lines back into tank.	Call for service following the procedures established for your site.

Table 7: Liquid Sensor Status Indicators - Piping Sump, Steel or Fiberglass Tank Interstitial Sensors

Display Message	Front Panel Indicator	Cause	Action
FUEL ALARM	Alarm	An interstitial or piping sump liquid sensor detects liquid in a tank's interstitial space or piping sump.	Call for service following the procedures established for your site.
SENSOR OUT ALARM	Alarm	A sensor is disconnected or is not functioning properly.	Call for service following the procedures established for your site.
		Liquid sensor setup was performed incorrectly.	Reenter this liquid sensor's setup values.

Table 8: Liquid Sensor Status Indicators - Normally Closed Sensors

Display Message	Front Panel Indicator	Cause	Action
FUEL ALARM	Alarm	An interstitial or piping sump liquid sensor detects liquid in a tank's interstitial space or piping sump.	Call for service following the procedures established for your site

Table 9: Liquid Status Sensor Indicators - Dual Float Differentiating (Hydrostatic) Sensors

Display Message	Front Panel Indicator	Cause	Action
HIGH LIQUID ALARM	Alarm	A sensor in a brine-filled interstice detects an increase in the brine level increase. Liquid is entering the riser pipe, or in a high groundwater area, an outer wall rupture has occurred.	Call for service following the procedures established for your site
LOW LIQUID ALARM	Warning	A sensor in a brine-filled interstice detects a decrease in the brine level. A hole is in the tank's inner wall, or in low groundwater areas, a hole is in the outer wall.	Call for service following the procedures established for your site.
SENSOR OUT ALARM	Alarm	A sensor is disconnected or is not functioning properly.	Call for service following the procedures established for your site.

Table 10: Liquid Status Sensor Indicators

Display Message	Front Panel Indicator	Cause	Action
Dual Float Discriminating Dispenser Pan and Containment Sump Sensors			
SHORT ALARM	Alarm	An internal short has occurred in the sensor.	Call for service following the procedures established for your site.
HIGH LIQUID ALARM	Alarm	Liquid reached 8" on the dispenser pan sensor or 10" on the containment sump sensor.	Immediately follow the alarm reporting procedures established for your site.
FUEL ALARM	Alarm	Fuel is present in the area being monitored by the sensor.	Immediately follow the alarm reporting procedures established for your site. Refer to the System Setup Manual for more information on recovering from an alarm due to leak or spill in the containment area.

Table 10: Liquid Status Sensor Indicators (Continued)

Display Message	Front Panel Indicator	Cause	Action
LIQUID WARNING	Warning	Liquid reached 1" on the dispenser pan or containment sump sensors.	Immediately follow the alarm reporting procedures established for your site.
SENSOR OUT ALARM	Alarm	The sensor is disconnected or is not functioning properly.	Sensor problem must be corrected or sensor replaced. Call for service by following the procedures established for your site.
		Liquid sensor setup was performed incorrectly.	Reenter this liquid sensor's setup values.
Oil/Water Separator Sensor			
SHORT ALARM	Alarm	An internal short has occurred in the sensor.	Call for service following the procedures established for your site.
FUEL ALARM	Alarm	Sensor indicates oil products volume has reached maximum.	Excess of oil products MUST pumped out IMMEDIATELY to prevent accidental oil discharge. Tank MUST be filled up with water for proper tank and sensor operation.
LIQUID WARNING	Warning	*Sensor indicates increasing oil* products volume.	*Oil pump-out to be scheduled. Oil* products to be pumped out before "FUEL ALARM" message displayed. Tank MUST be filled up with water for proper tank and sensor operation.
SENSOR OUT ALARM	Alarm	The sensor is disconnected or is not functioning properly.	Sensor problem must be corrected or sensor replaced. Call for service by following the procedures established for your site.
		Liquid sensor setup was performed incorrectly.	Reenter this liquid sensor's setup values.

Table 11: Vapor Sensor Status Indicators

Display Message	Front Panel Indicator	Cause	Action
FUEL ALARM	Alarm	A vapor sensor in an observation well detects fuel vapor levels that exceed the vapor alarm threshold set for that well.	Call for service following the procedures established for your site.
WATER ALARM	Warning	A vapor sensor is immersed in water and is incapable of detecting fuel vapors.	Call for service following the procedures established for your site
SENSOR OUT ALARM	Alarm	A vapor sensor is disconnected or is not functioning properly.	Call for service following the procedures established for your site.
SHORT ALARM	Alarm	An internal short has occurred in a vapor sensor.	Call for service following the procedures established for your site

Table 12: Receiver Status Indicator

Display Message	Front Panel Indicator	Cause	Action
AUTODIAL FAILURE	Alarm	System failed to connect to a remote receiver after "n" tries.	Check remote receiver.

Table 13: Pressurized Line Leak Detector Status Indicators

Display Message	Front Panel Indicator	Cause	Action
ANNUAL LINE FAIL	Alarm	0.10 gph line test failure. Dispensing halts while the alarm is active (only if system was programmed to shut down for a 0.10 gph leak).	Turn off dispensing nozzles. Follow the procedures in this manual to verify the leak. A 0.10 gph test must pass to clear this alarm.
CONTINUOUS PUMP ALARM	Alarm	Pump has been running for 16 hours.	This alarm shuts down the line. Call for service following the procedures established for your site.

Table 13: Pressurized Line Leak Detector Status Indicators (Continued)

Display Message	Front Panel Indicator	Cause	Action
CONTINUOUS PUMP WRN	Warning	Pump has been running for 8 hours.	Turn off the dispenser to reset.
GROSS LINE FAIL	Alarm	3.0 gph line test failure. Dispensing halts while the alarm is active.	Turn off dispensing nozzles. See the Leak Verification Procedure on page 159 to verify the leak.
HIGH PRESSURE ALARM	Alarm	Line leak detector components are not functioning properly (shuts off pump).	Call for service following the procedures established for your site.
HIGH PRESSURE WARN	Warning	Pressure relief components in the line are not functioning properly.	Call for service following the procedures established for your site.
LOW PRESSURE ALARM	Alarm	Low pump dispense pressure is detected during a dispense. Dispensing halts.	The next handle up will restart the pump.
PERIODIC LINE FAIL	Alarm	0.20 gph line test failure. Dispensing halts while the alarm is active (only if system was programmed to shut down for a 0.20 gph leak).	Turn off dispensing nozzles. See the Leak Verification Procedure on page 159 to verify the leak.
PLLD PERIODIC WARN	Warning	System fails to perform a periodic test (0.20 gph) in the programmed number of days. The number of days is set up in "Periodic Test Warnings," System Setup menu. Dispensing halts. A 0.20 gph test must pass to clear the alarm.	0.20 gph test must pass to clear the alarm. See the Leak Verification Procedure on page 159 to verify the leak.
PLLD PERIODIC ALARM	Alarm	System fails to perform a periodic test (0.20 gph) in the programmed number of days. The number of days is set up in "Periodic Test Alarms," System Setup menu. Dispensing halts. A 0.20 gph test must pass to clear the alarm.	0.20 gph test must pass to clear the alarm. See the Leak Verification Procedure on page 159 to verify the leak.
PLLD OPEN ALARM	Alarm	Pressure sensor reading is less than -3 psi. Only tested while the pump is running. Dispensing halts. If this alarm is triggered while a short alarm is active, the short alarm will be cleared.	3.0 gph test must pass to clear the alarm. Call for service following the procedures established for your site.

Table 13: Pressurized Line Leak Detector Status Indicators (Continued)

Display Message	Front Panel Indicator	Cause	Action
PLLD SHUTDOWN ALARM	Alarm	System shut down line because of failed line leak test	See above PLLD alarms for corrective action.
PRECISION LINE FAIL	Alarm	0.20 gph line test failure. Dispensing halts while the alarm is active (only if system was programmed to shut down for a 0.20 gph leak)	Turn off dispensing nozzles. See the Leak Verification Procedure on page 159 to verify the leak.
SHORT ALARM	Alarm	Possibly due to incorrect wiring, bad transducer, or stuck relay.	Call for service following the procedures established for your site.

Table 14: Wireless Pressurized Line Leak Detector Status Indicators

Display Message	Front Panel Indicator	Cause	Action
ANNUAL ALM	Alarm	0.10 gph line test failure. Dispensing halts while the alarm is active (only if system was programmed to shut down for a 0.10 gph leak).	Turn off dispensing nozzles. Follow the procedures in this manual to verify the leak. A 0.10 gph test must pass to clear this alarm.
ANNUAL LINE FAIL	Alarm	0.10 gph line test failure. Dispensing halts while the alarm is active (only if system was programmed to shut down for a 0.10 gph leak).	Turn off dispensing nozzles. Follow the procedures in this manual to verify the leak. A 0.10 gph test must pass to clear this alarm.
CONTINUOUS PUMP ALARM	Alarm	Pump has been running for 16 hours.	This alarm shuts down the line. Call for service following the procedures established for your site.
CONTINUOUS PUMP WRN	Warning	Pump has been running for 8 hours.	Turn off the dispenser to reset.
GROSS LINE FAIL	Alarm	3.0 gph line test failure. Dispensing halts while the alarm is active.	Turn off dispensing nozzles. See the Leak Verification Procedure on page 159 to verify the leak.
HIGH PRESSURE ALARM	Alarm	Line leak detector components are not functioning properly. (Shuts off pump.)	Call for service following the procedures established for your site.
HIGH PRESSURE WARN	Warning	The pressure relief components in the x are not functioning properly.	Call for service following the procedures established for your site.

Table 14: Wireless Pressurized Line Leak Detector Status Indicators (Continued)

Display Message	Front Panel Indicator	Cause	Action
PRECISION LINE FAIL	Alarm	0.20 gph line test failure. Dispensing halts while the alarm is active (only if system was programmed to shut down for a 0.20 gph leak).	Turn off dispensing nozzles. See the Leak Verification Procedure on page 159 to verify the leak.
WPLLD PERIODIC WARN	Warning	The system failed to perform a 0.20 gph (periodic) test in the programmed number of days. The number of days is set up in "Periodic Test Warnings," System Setup menu. A 0.20 gph test must pass to clear the alarm.	See the Leak Verification Procedure on page 159 to verify the leak.
WPLLD PERIODIC ALARM	Alarm	System fails to perform a 0.20 gph (periodic) test in the programmed number of days. The number of days is set up in "Periodic Test Warnings," System Setup menu. Dispensing halts. A 0.20 gph test must pass to clear the alarm.	See the Leak Verification Procedure on page 159 to verify the leak.
WPLLD OPEN ALARM	Alarm	WPLLD disconnected or is not functioning properly. A 3.0 gph test must pass to clear the alarm.	Call for service following the procedures established for your site.
WPLLD SHUTDOWN ALARM	Alarm	WPLLD has shut down. Alarm is cleared when alarm that caused the shutdown has cleared (3.0 gph line test, 0.20 gph line test, 0.10 gph line test, open alarm, or comm alarm). If the alarm was caused by a condition that disables dispensing, "Start WPLLD Line Test" appears in the display and the test begins.	Call for service following the procedures established for your site.
WPLLD COMM ALARM	Alarm	Communications disrupted between the system and WPLLD communications board. Alarm is cleared when communication resumes.	Call for service following the procedures established for your site.
CONTINUOUS PUMP WRN	Warning	Pump has been running for 8 hours.	Turn off the dispenser to reset.
CONTINUOUS PUMP ALARM	Alarm	Pump has been running for 16 hours.	This alarm shuts down the line. Call for service following the procedures established for your site.

Table 15: Volumetric Line Leak Detector Status Indicators

Display Message	Front Panel Indicator	Cause	Action
VLLD SELF TEST FAIL	Alarm	Line Leak Detector hardware failure.	Call for service following the procedures established for your site.
LINE LEAK SHUTDOWN	Alarm	Line test or pumpside test failure.	Call for service following the procedures established for your site.
LINE LEAK TEST FAIL	Alarm	Line Test or Pumpside Test Failure	Call for service following the procedures established for your site.
SELF TEST INVALID	Warning	A self-test failure during a requested test has occurred.	Run the same test again. If the system fails, call for service following the procedures established for your site.
CONTINUOUS PUMP WRN	Warning	The pump has not turned off for 2 hours	Call for service following the procedures established for your site.
GRS LINE TEST FAIL	Alarm	3.0 gph line test failure. (Three consecutive self-test failures.)	Call for service following the procedures established for your site.
GRS LINE SELF FAIL	Alarm	3.0 gph line self-test failure.	Run the same test again. If the system fails, call for service following the procedures established for your site.
GRS PUMP TEST FAIL	Alarm	3.0 gph pumpside test failure.	Run the same test again. If the system fails, call for service following the procedures established for your site.
GRS PUMP SELF FAIL	Alarm	3.0 gph pumpside self-test failure.	Run the same test again. If the system fails, call for service following the procedures established for your site.
VLLD PERIODIC WARN	Warning	The system failed to perform a 0.20 gph (periodic) test in the programmed number of days.	Call for service following the procedures established for your site.
VLLD PERIODIC ALARM	Alarm	The system failed to perform a 0.20 gph (periodic) test in the programmed number of days.	Call for service following the procedures established for your site.
VLLD ANNUAL WARNING	Warning	The system fails to perform a 0.10 gph (annual) test in the programmed number of days.	Call for service following the procedures established for your site.

Table 15: Volumetric Line Leak Detector Status Indicators (Continued)

Display Message	Front Panel Indicator	Cause	Action
VLLD ANNUAL ALARM	Alarm	The system fails to perform a 0.10 gph (annual) test in the programmed number of days.	Call for service following the procedures established for your site.
PER-LINE TEST FAIL	Alarm	0.20 gph line test failure. (Two consecutive self-test failures.)	Run the 0.20 gph test again. If the system fails, call for service following the procedures established for your site.
PER-LINE SELF FAIL	Alarm	0.20 gph line self-test failure.	Run the 0.20 gph test again. If the system fails, call for service following the procedures established for your site.
PER-PUMP TEST FAIL	Alarm	0.20 gph pumpside test failure.	Run the 0.20 gph test again. If the system fails, call for service following the procedures established for your site.
PER-PUMP SELF FAIL	Alarm	0.20 gph pumpside self-test failure.	Run the 0.20 gph test again. If the system fails, call for service following the procedures established for your site.
ANN-LINE TEST FAIL	Alarm	0.10 gph line test failure.	Call for service following the procedures established for your site.
ANN-LINE SELF FAIL	Alarm	0.10 gph line self-test failure. (Two consecutive self-test failures.)	Call for service following the procedures established for your site.
ANN-PUMP TEST FAIL	Alarm	0.10 gph Pumpside Test failure.	Call for service following the procedures established for your site.
ANN-PUMP SELF FAIL	Alarm	0.10 gph pumpside self-test failure.	Call for service following the procedures established for your site.
VLLD PRESSURE WARN	Warning	Three consecutive attempts to run a test in which the pressure switch never opened (pump not running).	Call for service following the procedures established for your site.
VLLD PRESSURE ALARM	Alarm	Six consecutive attempts to run a test in which the pressure switch never opened (pump not running).	Call for service following the procedures established for your site.
FUEL OUT	Alarm	Product level below 10 inches and three consecutive 3.0 gph self-test failures.	Call for delivery.

Table 15: Volumetric Line Leak Detector Status Indicators (Continued)

Display Message	Front Panel Indicator	Cause	Action
VLLD TEST FAULT - GRS	Alarm	Line leak detector hardware failure	Call for service following the procedures established for your site.
VLLD TEST FAULT - PER	Alarm	Line leak detector hardware failure	Call for service following the procedures established for your site.
VLLD TEST FAULT - ANN	Alarm	Line leak detector hardware failure	Call for service following the procedures established for your site.
TEST CURRENTLY ON HOLD	None	3.0 gph self-test failure or VLLD PRESSURE WARN alarm.	Retest to validate outcome on next dispense. After 3rd occurrence, system will alarm. After 6th occurrence, system will shut down.

Table 16: Groundwater Sensor Status Indicators

Display Message	Front Panel Indicator	Cause	Action
FUEL ALARM	Alarm	A groundwater sensor in an observation well detects fuel.	Call for service following the procedures established for your site.
WATER OUT ALARM	Warning	Water level is below the float switch making the groundwater sensor ineffective.	Call for service following the procedures established for your site.
SENSOR OUT ALARM	Alarm	The sensor is disconnected or is not functioning properly.	Call for service following the procedures established for your site.
SHORT ALARM	Alarm	An internal short has occurred in the sensor.	Call for service following the procedures established for your site.

Table 17: 2-Wire C.L. Discriminating Interstitial Sensor Status Indicators

Display Message	Front Panel Indicators	Cause	Action
FUEL ALARM	Alarm	A sensor has detected fuel.	Call for service following the procedures established for your site.
WATER ALARM	Warning	A sensor has detected water	Call for service following the procedures established for your site.
SENSOR OUT ALARM	Alarm	The sensor is disconnected or is not functioning properly.	Call for service following the procedures established for your site.
SHORT ALARM	Alarm	An internal short has occurred in the sensor.	Call for service following the procedures established for your site.

Table 18: 2-Wire C.L. Discriminating Interstitial Micro Sensor Status Indicators

Display Message	Front Panel Indicator	Cause	Action
SHORT ALARM	Alarm	An internal short has occurred in the sensor.	Call for service following the procedures established for your site.
FUEL ALARM	Alarm	Liquid is present in the area being monitored by the sensor.	Immediately follow the alarm reporting procedures established for your site.
SENSOR OUT ALARM	Alarm	The sensor is disconnected or is not functioning properly.	Sensor problem must be corrected or sensor replaced. Call for service following the procedures established for your site.
		Liquid Sensor setup was performed incorrectly.	Reenter this liquid sensor's setup values.

Table 19: 3-Wire C.L. Sensor Status Indicators

Display Message	Front Panel Indicator	Cause	Action
FUEL ALARM	Alarm	A dispenser pan or containment sump sensor has detected fuel.	Call for service following the procedures established for your site.
HIGH LIQUID ALARM	Alarm	A sensor detects a high liquid level.	Call for service following the procedures established for your site.
LIQUID WARNING	Alarm	A sensor detects a small amount of liquid.	Call for service following the procedures established for your site.
SENSOR OUT ALARM	Alarm	The sensor is disconnected or is not functioning properly.	Call for service following the procedures established for your site.
SHORT ALARM	Alarm	An internal short has occurred in the sensor.	Call for service following the procedures established for your site.

Table 20: External Input Messages

Display Message	Front Panel Indicator	Cause	Action
EXTERNAL INPUT ALARM	Alarm	External device changed from preset condition.	Check the operation of the external device.
GENERATOR ON (In emergency generator applications only.)	None	Backup generator went online, in-tank leak testing halted.	Wait until power is restored
GENERATOR OFF (In emergency generator applications only.)	None	Backup generator shut down, in-tank leak testing resumed.	None.

Table 21: Business Inventory Reconciliation (BIR) Messages*

Display Message	Front Panel Indicator	Cause	Action
CLOSE SHIFT PENDING	Warning	The system is waiting for an idle period to close for a shift report.	System clears itself after idle period and shift closes.
CLOSE DAILY PENDING	Warning	The system is waiting for an idle period to close for a daily shift report.	System clears itself after idle period and shift closes.
PROD THRESHOLD ALM	Alarm	The variance exceeded the calculated threshold for the periodic report.	Press the Alarm/Test key to acknowledge the alarm and clear the display.
DISABLED DIM ALARM	Alarm	No communication between ECPU board and DIM board.	Call for service following the procedures established for your site.
COMMUNICATION ALARM	Alarm	No communication between DIM board and an external device.	Call for service following the procedures established for your site.

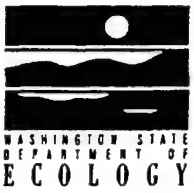
* TLS-350R only

Appendix B: State of Washington Summary of Requirements for USTs, Publication No. 94-32

Summary of Requirements for

Underground Storage Tanks:

Release Detection
Corrosion Protection
Spill/Overfill Prevention



These tables summarize portions of the Washington State Underground Storage Tank Regulations (Chapter 173-360 WAC). For more information consult the regulations or call the Department of Ecology at one of the number listed inside.

Publication # 94-32

3/14/94

WHAT DO YOU HAVE TO DO?

Minimum Requirements

"NEW" tanks and piping are those installed after December 1988.
"EXISTING" tanks and piping are those installed before December 1988.

RELEASE DETECTION	
NEW TANKS *2 Choices*	● Monthly Monitoring[1] ● Daily Inventory Control and Tank Tightness Testing Every 5 Years (You can only use this choice for 10 years after installation.)[2]
EXISTING TANKS *3 Choices*	● Monthly Monitoring[1] ● Daily Inventory Control and Annual Tank Tightness Testing (This choice can only be used until December 1998.) ● Daily Inventory Control and Tank Tightness Testing Every 5 Years (This choice can only be used for 10 years after adding corrosion protection and spill/overfill prevention or until December 1998, whichever date is later.)[2]
NEW & EXISTING PRESSURIZED PIPING *Must have one from each set*	● Automatic Flow Restrictor ● Automatic Shutoff Device ● Continuous Alarm System ***and*** ● Annual Line Testing ● Monthly Monitoring[1,3]
NEW & EXISTING SUCTION PIPING *3 Choices*	● Monthly Monitoring[1,3] ● Line Testing Every 3 Years ● No Requirements if piping meets certain conditions[4]
CORROSION PROTECTION	
NEW TANKS *3 Choices*	● Coated and Cathodically Protected Steel ● Fiberglass ● Steel Tank Clad with Fiberglass (Composite)
EXISTING TANKS *4 Choices*	● Same Options as for New Tanks ● Add Cathodic Protection System ● Interior Lining ● Interior Lining and Cathodic Protection
NEW PIPING *2 Choices*	● Coated and Cathodically Protected Steel ● Fiberglass
EXISTING PIPING *2 Choices*	● Same Options as for New Piping ● Cathodically Protected Steel
SPILL/OVERFILL PREVENTION	
ALL TANKS	● Catchment Basin ***and*** ● Automatic Shutoff Device **or** ● Overfill Alarm **or** ● Ball Float Valve

[1]*Monthly monitoring methods for tanks include Automatic Tank Gauging, Vapor Monitoring, Interstitial Monitoring, Ground Water Monitoring and other approved methods.*

[2]*Tanks under 2000 gallons may also be able to use weekly tank gauging (see WAC 173-360-345).*

[3]*Monthly monitoring methods for piping do not include Automatic Tank Gauging.*

[4]*Only one check valve which is located directly below the dispenser and piping is sloped towards the tank.*

WHEN DO YOU HAVE TO ACT?

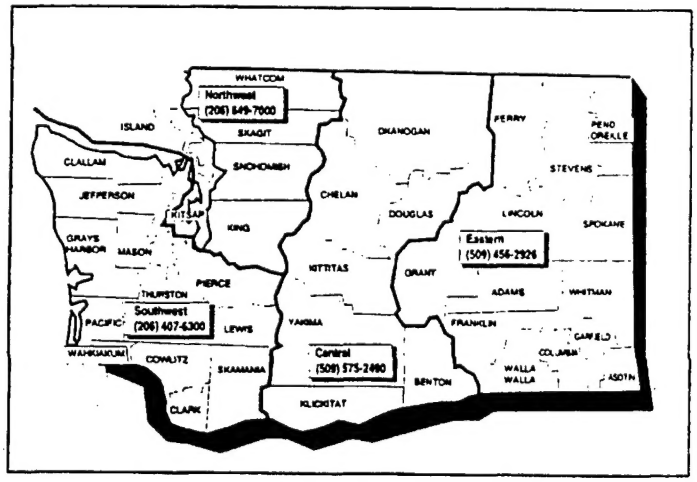
Important Deadlines

"NEW" tanks and piping are those installed after December 1988.
"EXISTING" tanks and piping are those installed before December 1988.

TYPE OF TANK & PIPING	RELEASE DETECTION	CORROSION PROTECTION	SPILL/OVERFILL PREVENTION
New Tanks and Piping	At installation	At installation	At installation
Existing Tanks[1] Installed: Before 1965 or unknown 1965 - 1969 1970 - 1974 1975 - 1979 1980 - December 1988	***By No Later Than:*** December 1989 December 1990 December 1991 December 1992 December 1993	December 1998	December 1998
Existing Piping Pressurized Piping Suction Piping	 December 1990 If required, same as existing tanks	 December 1998 December 1998	 Does not apply Does not apply

[1]*Deadlines for release detection on emergency power generator tanks are extended two years beyond this schedule (i.e., such tanks installed in 1970-1974 must have release detection by December 1993, rather than 1991, etc.).*

Who can you call for more information?



CERL Distribution

Fort Lewis, WA
ATTN: AFZH-DWS-RNB (2)
Chief of Engineers
ATTN: CEHEC-IM-LH (2)
ATTN: HECSA Mailroom (2)
ATTN: CECC-R

Engineer Research and Development Center (Libraries)
ATTN: ERDC, Vicksburg, MS
ATTN: Cold Regions Research, Hanover, NH
ATTN: Topographic Engineering Center, Alexandria, VA

Defense Tech Info Center 22304
ATTN: DTIC-O

11
3/01

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE (DD-MM-YYYY)	2. REPORT TYPE	3. DATES COVERED (From - To)
03-2001	Final	

4. TITLE AND SUBTITLE
Management System for Fluid Storage Tanks at Fort Lewis, WA

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Jearldine I. Northrup, Joyce C. Baird, Donald J. Schiller, and James F. Lee

5d. PROJECT NUMBER
MIPR

5e. TASK NUMBER

5f. WORK UNIT NUMBER
0CCERL3012

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Engineer Research and Development Center (ERDC)
Construction Engineering Research Laboratory (CERL)
P.O. Box 9005
Champaign, IL 61826-9005

8. PERFORMING ORGANIZATION REPORT NUMBER
ERDC/CERL TR-01-27

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Fort Lewis
P.O. Box 339500
Fort Lewis, WA 98433-9500

10. SPONSOR/MONITOR'S ACRONYM(S)
AFZH-DWS-RMB

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES
Copies are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

14. ABSTRACT

Fort Lewis Military Reservation is a large Army installation located in western Washington State. Some of the organizations at Fort Lewis require the use of hazardous substances and generate hazardous waste. The U.S. Army Engineer Research and development Center (ERDC), Construction Engineering Research Laboratory (CERL) was tasked with electronically consolidating fluid storage tank information for underground storage tanks (USTs) and aboveground storage tanks (ASTs) at Fort Lewis. This work performed the first of three steps to monitor storage tanks at Fort Lewis by demonstrating an integrated storage tank monitoring system of limited scope. Later work will assess methods to connect all regulated tanks to the monitoring system computer, and a third task will connect as many of the remaining unregulated tanks to the monitoring system as possible.

15. SUBJECT TERMS
Fort Lewis, WA
underground storage tanks (UST)
aboveground storage tanks (AST)
waste management
alarm system
monitoring

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
					Jearldine I. Northrup
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER (include area code)
Unclassified	Unclassified	Unclassified	SAR	40	(217) 373-4472